



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Covid-19 need not spell the death of public transport: Learning from Hanoi's safety measures

Minh Hieu Nguyen^{a,*}, Dorina Pojani^b

^a Faculty of Transport - Economics, University of Transport and Communications, No. 3 Cau Giay Street, Dong Da District, Hanoi, Vietnam

^b The University of Queensland, Brisbane, Australia

ARTICLE INFO

Keywords:

Covid-19 pandemic
Public transport
Buses
Health and safety
Hanoi
Vietnam

ABSTRACT

Objectives: In contrast to other cities worldwide, the pandemic has not decimated bus ridership in Hanoi. Notably, the Vietnamese capital has mostly relied on the use of face masks and hand sanitizer during travel, instead of requiring physical distancing on buses. This study examines public bus passengers' levels of compliance with Covid-19 safety measures, and the factors that affect compliance.

Methods: Face-to-face surveys were administered between 7 September and 3 October 2020, right after the end of the third wave of Covid-19 in Hanoi on 51 bus routes. Exploratory Factor Analysis was carried out to extract factors from attitudinal statements. The extracted factors, passengers' socio-demographic traits, and their bus use patterns were modelled to determine which variables lead to more compliance with Covid-19 safety measures.

Results: We found that 100% of passengers wore face masks (which were mandated), albeit 11% did so incorrectly, while only 28% of passengers used the hand sanitizer provided by bus operators (which was recommended but not required). In addition, 38% of passengers carried their own bottles of hand sanitizer while travelling, despite a relatively low risk of contracting the virus. Women, older passengers, and urbanites were less likely to sanitise their hands. Frequent bus travellers behaved like the population at large with regard to protective measures against Covid-19.

Conclusions: Hanoi's overall measures - full use of face masks and partial use of hand sanitizer - were sufficient to contain three relatively minor Covid-19 waves while still maintaining regular bus operations most of the time. If other cities were able to reach these levels of compliance, most would be in much better position vis-à-vis public transport use during the pandemic (or an epidemic). Our findings suggest that mandates work much better than awareness raising campaigns, although the latter have a role to play.

1. Introduction

While mobility is vital to the well-functioning of cities and counties, travel can also act as a major spreader of disease (De Vos, 2020; Musselwhite et al., 2020; Rocklöv et al., 2020; Shen et al., 2020; Zhao et al., 2020; Zheng et al., 2020). Mobility restrictions, cancellations of major public events, and mass adoption of telecommuting led to a dramatic drop in travel demand during the Covid-19 pandemic, especially in the first stages. For example, in the Netherlands, the number of all trips decreased by more than half in 2020,

* Corresponding author.

E-mail addresses: hieunm@utc.edu.vn (M.H. Nguyen), d.pojani@uq.edu.au (D. Pojani).

and the travelled distances contracted considerably (de Haas et al., 2020). Budapest also experienced a decrease in mobility by about half (Bucsky, 2020).

But a reduced travel demand impacted transport modes differently: individual modes (cars and micromobility) which limit contact with others were preferred over collective modes (buses and trains). For example, over the course of 2020, the share of driving in Budapest increased from 43% to 65% (Bucsky, 2020). In post-lockdown Australian cities, driving levels exceeded pre-pandemic levels (Sipe, 2020). In South Korea, car sales in March–April 2020 were higher than during the same period of the previous year (Sung and Monschauer, 2020). Similar growth rates were reported for cycling, scooter use, bicycle purchases, and bikesharing around the world (Sung and Monschauer, 2020; Teixeira and Lopes, 2020).

In contrast, public transport ridership declined. For example, in the three most populated regions of Sweden, the decline was in the range of 40%–60% (Jenelius and Cebecauer 2020). In Budapest, the public transport mode share fell from 43% to a meagre 18% (Bucsky, 2020). In Spain, transit use at the end of June 2020 had declined by 40% compared to June 2019 (Orro et al., 2020). In Australia's largest cities, bus, tram, and train ridership declined by 80–89% (Sipe, 2020). The concern is that these changes will be long-lasting (de Haas et al., 2020). Early research results in China and the Netherlands suggest that more people intend to drive in the future than before the pandemic (de Haas et al., 2020; Li et al., 2020).

Widespread public fears around public transport use are understandable. The virus that causes Covid-19 (SARS-CoV-2) spreads via droplets while talking, coughing, and sneezing, and exposure is higher in enclosed, potentially crowded environments such as a bus or a train car (De Vos, 2020; Funk et al., 2010; Guellich et al., 2021; Shen et al., 2020). Moreover, the virus can survive for long periods of time depending on the surface material: up to 4 h on copper, up to 9 h on human skin, up to 24 h on cardboard, and up to several days on plastic or steel (van Doremalen et al., 2020; Hirose et al., 2020). New virus mutations are more infectious than earlier variants. Therefore, even buses or trains that are sanitized on a daily basis pose a risk of transmission.

Yet, public transport is vital to cities (Nguyen-Phuoc et al., 2020; Pojani and Stead, 2015) and its preservation in a post-pandemic world is essential. For safety, a series of non-pharmaceutical measures must be widely adopted while on board and at stops, including: (1) adoption of physical distancing (2) wearing of face masks, and (3) sanitising hands (Tirachini and Cats, 2020). Ideally, these measures should be used in combination rather than in isolation, but some have been more controversial than others.

Throughout 2020, a number of cities established 'safe distance' thresholds for their public transport systems. These ranged from 1 m in Milan to 6 feet (1.8 m) in New York (World Bank, 2020). As a result of these rules, in Shenzhen and Madrid, public transport had to operate at less than half and less than a quarter of the normal capacity respectively (World Bank, 2020). In Nigeria, a row of five seats could not carry no more than three passengers at a time (Dzisi and Dei, 2020). Cities were willing to apply distancing rules although they reduced the carrying capacity of vehicles, thus increasing operating costs and undermining the service frequency (Tirachini and Cats, 2020).

Wearing face masks in public spaces met with more resistance compared to the other measures. The World Health Organization itself caused some confusion at the outset by recommending the use of masks for symptomatic individuals only (Tirachini and Cats, 2020). Later, as it became clear that in over half of the cases patients were asymptomatic or only presented mild symptoms (Wang et al., 2020), many countries, in particular in East Asia, mandated the use of masks (surgical or fabric) at all times while outdoors. This helped places such as China, Singapore, Taiwan, Hong Kong, and South Korea, to control the pandemic rather effectively (Prather et al., 2020). In other countries, where masks are only recommended but not required, use remained low. For example, in Ghana, fewer than 13% of public transport riders used face masks (Dzisi and Dei, 2020).

So far, very little is known on the usage rates of hand sanitizer in public transport systems. Anecdotally, the use of hand sanitizer appeared to be common where this was provided for free at stations, stop, or aboard vehicles. However, alcohol-based sanitizers can be hazardous (Mahmood et al., 2020), thereby leading many passengers to avoid them. A Paris-based study showed that barely 8% of respondents used alcohol-based hand sanitizer on board (Guellich et al., 2021).

In this study set in Hanoi in 2020, we examine passengers' levels of compliance with safety measures aboard public buses, and the factors that affect compliance. We also provide suggestions on how to improve compliance. Hanoi, a megacity of more than 8 million, was selected as a case study because it is considered as a success story in terms of Covid-19 containment (CNN, 2020). Unlike previous studies that relied on third party data, such as mobile phone and subscription card data (Orro et al., 2020; Sipe, 2020; Teixeira and Lopes, 2020), this study of Hanoi employed original surveys of bus users. By way of context, in Hanoi face masks must be worn in public spaces (including buses) at all times and bus passengers are expected to follow other rules and guidelines. Physical distancing is not required aboard buses but hand sanitising is encouraged and sanitizer bottles are provided on board.

Owing to these measures, bus ridership was not decimated in Hanoi, and by the end of 2020 it was already poised to return to pre-pandemic levels (see Table 1). The findings in Hanoi can help planners and public health officials draw lessons for other cities that are still struggling with the pandemic. Beyond Covid-19, Hanoi's approach can help contain more local epidemics.¹ We must note, however, that Covid-19 infections rates and deaths have been much lower in Vietnam than elsewhere (fewer than 20,000 cases and fewer than 100 deaths in total as of July 2021).

2. Background on Hanoi's public transport system

Before proceeding to the empirical portion of the study, we discuss Hanoi's public transport supply and demand before the Covid-

¹ Since the turn of the millennium, diseases such as SARS, MERS, Ebola, H5N1 have posed a major risk at the global level, although they were eventually contained.

Table 1
Pandemic timeline and bus ridership in Hanoi.

Month (2020)	Bus ridership (million)	Bus operation	Covid-19 timeline
Jan	27.1	Normal operation; New Lunar Year holiday	Wave 1
Feb	19.2	Schools and universities closed	
Mar	15.6	Schools and universities closed	Wave 2
Apr	0.63	Nationwide physical distancing required	
May	19.2	Physical distancing requirements lifted & universities re-open	No community transmission
Jun	21.9	Normal operation	
Jul	20.9	Normal operation	Wave 3
Aug	15.2	Normal operation	
Sep	20.8	Normal operation	No community transmission
Oct	25.3	Normal operation	

19 pandemic, and the city's strong response to the pandemic.

2.1. Public transport supply and demand before the Covid-19 pandemic

In Hanoi, motorcycles are the dominant transport mode whereas public transport and bicycle use is relatively low (Nguyen and Armoogum, 2020; Nguyen and Pojani, 2018; Tuan and Mateo-Babiano, 2013). The government has enabled automobility by investing in road infrastructure more than in public transport and by applying few controls on car ownership and use. Only 8% of trips take place on public transport (TRAMOC, 2019), which comprises conventional buses and a BRT line. However, in a megacity, this still translates into millions of monthly bus trips, and, given current levels of congestion and pollution, it would be disastrous if most of those trips were converted to car or even motorcycle trips (OECD, 2018; Nguyen et al., 2019b; Nguyen-Phuoc et al., 2019). Meanwhile, Hanoi's public transport system has experienced many ups and downs along its hundred-year long history. Up until the 1980s, the city had five tramway lines and one trolleybus line. Most were inherited from the French colonial period, and a few were built by the communist government. All of these were dismantled in the 1990s due to safety concerns and low commercial speeds.

A conventional bus system was introduced since the 1960s, which was reasonably successful through the 1980s, owing to a mass of captive riders. Vietnam's shift from a command-and-control economy to a market economy in 1986 was accompanied by a cut in public transport funding (Yeung, 2007). Thereafter, the Hanoi bus system went into crisis mode. In an effort to revive it, public subsidies were reinstated in 1992. In conjunction, the city invested in new and modern vehicles and expanded the route network (from 31 in 2000 to 104 by 2019). In 2001, the various bus companies were merged into a single state-owned enterprise (Transerco) to facilitate service integration. A promotional campaign was also launched, the motto being "the bus is faster than the bicycle and cheaper than the motorcycle." This major reform became a national model for public transport development and led to substantial growth in bus ridership (Fig. 1).

A new BRT line was created in 2017, with support from the World Bank. While this has shortened travel times for people living and working in proximity to stations (Hoang-Tung et al., 2020), overall it has underperformed. With a daily ridership of only about 14,500 passengers, expansion plans have been scrapped (Nguyen et al., 2019a, 2020a; Nguyen and Pojani, 2018). Currently, the BRT line is managed by a state-owned company, Transerco, along with the conventional bus network. A pilot of the first metro line (connecting Ha Dong and Cat Linh) was launched in 2018 but the timeline for launching commercial operations has not been announced, as major safety concerns have been raised. The second line, running from Hang Co to Nhon, is still under construction. The metro lines are receiving support from Chinese and French investors, the Asian Development Bank, and the European Investment Bank, and a new state-owned company, the Hanoi Metro Company, has been established to run the metro.

This is the context in which the Covid-19 pandemic hit.

2.2. Response to the Covid-19 pandemic and impact on public transport

In 2020, Vietnam experienced three waves of Covid-19, delineated below. Bus ridership data along the progression of the pandemic are reported in Table 1.

First wave. The first case in Vietnam was confirmed on 23 January. By 25 February, 15 additional cases had been confirmed around the country, including some in Ho Chi Minh City. The Vietnamese government took immediate action, quarantining people presenting Covid-19 symptoms, applying lockdowns in areas with known infectious clusters, suspending face-to-face teaching in schools and universities, sanitising high-use areas, and recommending frequent hand washing and mask wearing in public places (Nguyen et al., 2021a,b). Thus the first wave came to an end rather quickly. Bus services in Hanoi continued to operate as normal during this time, as the capital had no confirmed cases. Nevertheless, the ridership was reduced significantly because students, the main bus patrons (Nguyen et al., 2017) stop commuting during university closures.

Second wave. The 17th positive case (the first one in Hanoi) was recorded on 6 March. This marked the beginning of the second wave. The number of cases snowballed thereafter, and Bach Mai, one of the largest hospitals in Hanoi, became an epicentre of the disease. Many province leaders urged the prime minister to issue strict directives. On 1 April, the government mandated nationwide

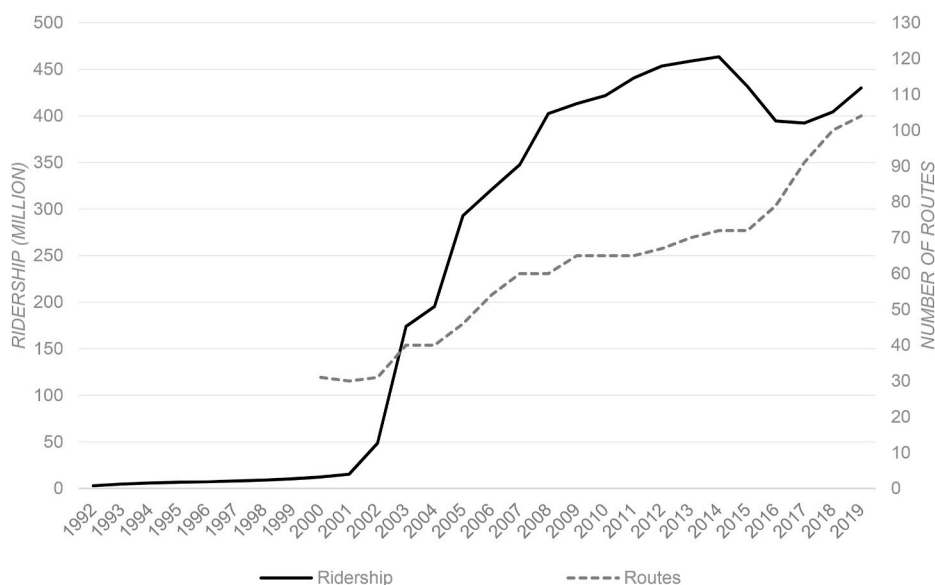


Fig. 1. Growth in bus ridership and network size.

Notes: To compute ridership statistics, we use direct counts of single one-way tickets and estimates of trips employing monthly multi-route subscriptions. In 2008, Hanoi incorporated some neighbourhood provinces. Consequently, the total number of routes in Hanoi increased, and eventually all routes were included in the state subsidy scheme.

lockdowns (Nguyen, 2021). People at high risk of spreading the virus were moved to hospitals or quarantine centres. Going out was allowed only for absolute necessities such as food shopping. Physical distancing requirements (2 m) applied while outdoors, and masks had to be worn. All gatherings were prohibited, and all but essential services (grocery stores, pharmacies, and fuel stations) were shut. Regular hand washing was highly recommended. A recent survey of 2175 people spread around Vietnam found that compliance with safety measures was high, especially in locations that had more confirmed cases (Nguyen et al., 2020b). A full 99.5% of survey respondents wore masks when going out. In this manner, the second wave was successfully contained too. By the second half of April, community transmissions completely halted. Therefore, physical distancing requirements were lifted at the end of April.² In Hanoi, public buses discontinued operations between 28 March and 23 April. Then, between 24 April and 5 May, the buses operated at 20–30% of the normal frequency. No more than 30 people were allowed on board at one time, including the driver and the conductor, and the distance between passengers had to be at least 1 m. Chatting and eating on board were limited while air-conditioning was turned off. On May 7, the physical distancing requirement on buses was lifted. However, passengers were encouraged to clean their hands with sanitizer containing at least 60% alcohol when boarding a bus (Ministry of Health, 2020). Bottles of sanitizer were provided on the vehicles.

Third wave. On 26 July, after 99 continuous days of no community transmissions, a new case was detected in a Da Nang hospital. This led to a new breakout, which resulted in the first Covid-19 death in Vietnam, on 31 July. Several districts, including some in Da Nang, went back into strict lockdown. This way, the third wave was abated by 2 September. No new cases have been recorded since. In Hanoi which was much less infected, the preventive measures were less strict in this round. However, the local government sent out regular reminders regarding the obligatory use of masks while outdoors and the benefits of frequent hand washing and sanitising. Bus services continued their normal operations, without physical distancing on board. Ridership experienced a dip in August but recovered in September and grew further in October (see Table 1).³

3. Methodology

The data collection and analysis procedures are delineated below.

3.1. Data collection

To examine bus passengers' compliance with Covid-19 safety measures, we conducted a survey of bus users. The survey was administered between 7 September and 3 October 2020, right after the end of the third wave (Fig. 2). The questionnaires were administered in face-to-face interviews. The passengers of 51 bus routes were approached with a request to complete a survey. Two to

² On 30 April 2020 in Hanoi but a week earlier in lower risk areas.

³ Before this article went to press, Hanoi experienced another Covid-19 wave in May–September 2021 with the 2nd lockdown mandated.

three surveyors (wearing protective equipment, such as masks and gloves) rode on each bus to collect the surveys. Of the routes selected for inclusion (nearly half of all Hanoi routes), 24 operated within the urban area only, 25 operated across the urban and metropolitan areas, and 2 covered the outer region only (Fig. 3). This sample distribution was compatible with the overall distribution of bus routes in Hanoi. To achieve temporal representation, surveys were conducted both on weekdays and at weekends.

The survey had four portions. In the first portion, we collected information on bus use habits and the use of hand sanitizer while on board. The second portion comprised attitudinal statements (ranked on a five-point Likert scale) about using hand sanitizer and face masks, the pandemic more generally, and concerns around bus travel (e.g., pickpocketing). Three items designed to measure the fear of Covid-19 infection were adapted from Ahorsu et al. (2020) and Nguyen and Armoogum (2021). Three items measured the quality and availability of hand sanitizer (Selam, 2020). Two items were included to account for the possibility that passengers do not use sanitizer due to distraction by other concerns such as pickpocketing (Ding and Zhai, 2021) or finding a seat (Alam and Werth, 2008). A final item asked whether passengers believed that the used of face masks reduced the need to use hand sanitizer. This was based on the cognitive stress theory, according to which, during stressful situations people tend to adopt coping strategies selectively rather than comprehensively (Homburg and Stolberg, 2006; Lazarus, 1994). In an open-ended question, respondents were asked to provide any suggestions for increasing compliance with safety measures on buses.

In the third portion of the questionnaire, we collected demographic data (age, gender, occupation, residential location, educational level, and existing health issues). The final portion of the survey form contained the surveyor's observations. It recorded observations on the number of hand sanitizer bottles on board and whether the respondent (bus passenger) was wearing the face mask incorrectly (i. e., the mask was not covering the person's mouth or nose or was being worn upside down).

An additional 6% of people who initially agreed to participate were excluded from the survey as they reported being allergic to hand sanitizer. After removing incomplete questionnaires (32), the final sample resulted in 570 responses eligible for quantitative analysis. Only 243 respondents (43% of the total) answered the open-ended question, and those responses were treated as qualitative data.

3.2. Analytical procedure

All the statistical analyses were conducted in Stata 15.0. First, descriptive statistics of the data were computed. Then, the attitudinal statements were reduced through exploratory factor analysis. We employed principal component analysis (eigenvalue > 1, Oblimin rotation method with Kaiser normalization). Finally, two logit models were estimated:

Model 1, a binary logit model, was applied to the entire sample to determine whether a passenger used hand sanitizer on board and why. The independent variables included gender, age, occupation, education, living area, bus use frequency, ticket type, carrying of heavy luggage, carrying of personal hand sanitizer, proper use of face mask, existing health issues, number of sanitizer bottles on board, and factors extracted from attitudinal items.

Model 2, an ordered logit model, measured the frequency of using hand sanitizer on board. This model was applied to a subsample of passengers travelling by bus at least twice per week (345 respondents or 60% of the total). The list of independent variables included: gender, age, occupation, education, residential location, ticket type, carrying of personal hand sanitizer, existing health issues, and factors extracted from attitudinal items. The findings from the descriptive statistics, the exploratory factor analysis, and the two models are discussed below.

4. Findings and discussion

4.1. A broad overview: descriptive statistics and data reduction

Table 2 shows the descriptive statistics for the full sample and the subsample of frequent bus users. The overall response rate was very high, at 90%, as noted. In both samples, the gender distribution was balanced. The vast majority of bus passengers was under 30, suggesting high bus use among students, as expected. This also explains why most passengers did not have a university degree (yet). A cluster of users comprised older people, many on lower incomes. People living close to the city centre were much more likely to be bus users. Slightly more than half of all passengers used monthly subscriptions, while only 6% benefited from concessions.⁴ Among frequent users, over three fourths had monthly subscriptions while the rate of concessions was the same as for the entire sample. Many passengers (11%) carried heavy luggage during their bus trip. The overwhelming majority did not report any health issues (that would place them at higher risk in case they contract Covid-19).

All respondents wore masks while on the bus. However, masks were incorrectly used in 11% of cases. At least one bottle of hand sanitizer was provided in all the surveyed buses (usually two bottles). Yet, only 28% of respondents used hand sanitizer on board – although very few reported having an adverse reaction to alcohol-based hand sanitisers. Among frequent bus users, only a fifth reported using hand sanitizer regularly.

However, many passengers (38%–43%) carried personal hand sanitizer bottles. Also, many were quite scared of the prospect of contracting Covid-19, and believed that masks alone were insufficient to protect against infection (Table 3). The responses to

⁴ Free tickets for passengers over 60.

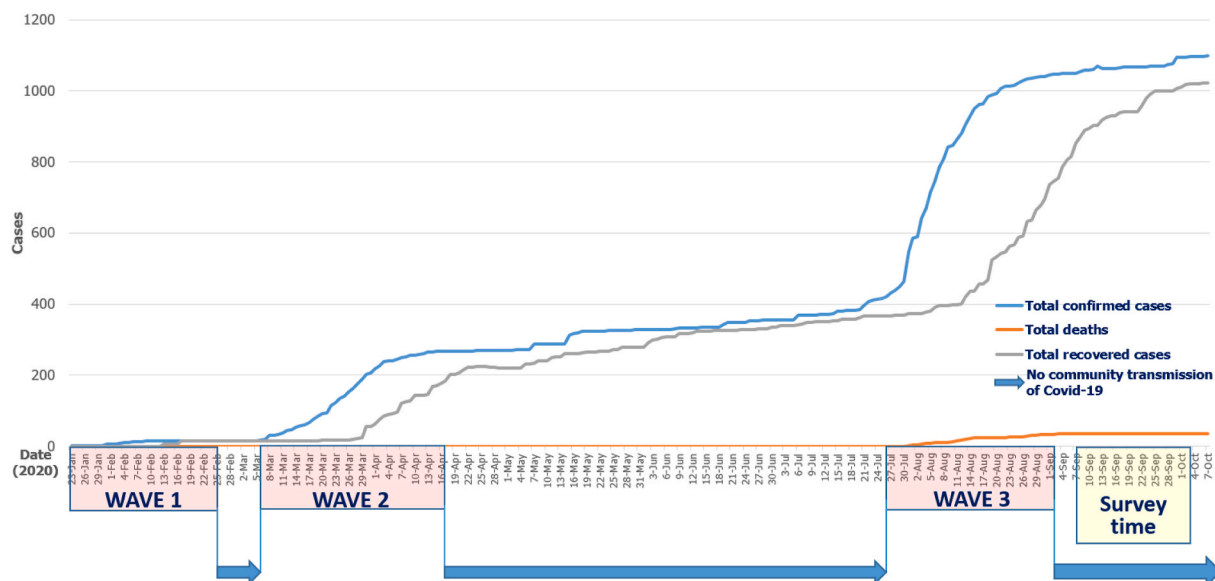


Fig. 2. Progression of Covid-19 in Vietnam and survey collection period.

attitudinal questions suggested that a low rate of hand sanitising may be partly due to too few bottles being provided for free on buses and those being nearly empty most of the time. Some people believed that free sanitizer is of low quality and therefore useless. Another portion of passengers shunned hand sanitising because they were preoccupied with finding a seat or comfortable standing spot when boarding a bus, or they were worried that they might fall prey to pickpocketing if they were distracted even momentarily.

Upon analysing the suggested solutions to improve 'health and safety' on buses. All the suggestions were first summarized and then grouped based on similarity of content. This process produced nine groups, of which the top five had the highest frequencies by far (Table 4). Most respondents requested that more sanitizer be offered on buses but only 13% believed that hand sanitising should be obligatory for bus passengers. No objections were raised about the requirement to use masks while riding buses.

The data collected through attitudinal questions were reduced into four factors (types of perceptions): (1) The pandemic is scary; (2) The sanitizer on-board is no good; (3) Bus travel can be un-comfortable; and (4) Masks are sufficiently protective (Table 5). These four factors were then used in the modelling exercises discussed below.

4.2. Modelling results: who uses protective measures, how often, and why?

The results of Model 1 are presented in Table 6. We focused on the use of hand sanitizer given that masks were universally worn whereas physical distancing requirements have been lifted, as noted. Our analysis showed that women were less likely to use hand sanitizer on buses compared to men. This was rather surprising given that women are generally more risk averse and more likely to comply with public health measures – as found in studies based in Japan and Switzerland (Machida et al., 2020; Nivette et al., 2021).

Similarly, older passengers (over 45) were less likely to use the hand sanitizer provided on the bus compared to people under 30. The relationship was statistically significant albeit weak. Again, this was counterintuitive given that Covid-19 is known to pose a higher risk among older people (CDC, 2020). In fact, having health issues increased the likelihood of using hand sanitizer. In the case of very old people, perhaps fear of walking around a moving bus to reach a hand sanitizer bottle led to low use. Where buses offered more bottles, the rates of usage went up. But more needs to be done – for example, conductors could be instructed to help older passengers by spray sanitizer on their hands.

Residential location was also influential in the choice of using hand sanitizer with passengers from rural areas being more inclined to sanitise their hands compared to urbanites. This result is incompatible with the finding of Nguyen et al. (2020b) that urban residents in Vietnam are more likely to adhere to preventive measures. On the face of it, it was also surprising given that most confirmed cases have been concentrated in cities rather than villages.

Possibly, there is a common explanation for these findings. It may be that women, urbanites, and older people were better informed on disease risks and, therefore, did not rely on the sanitizer which is freely provided on buses but rather carried their own, higher quality one, so as to be more protected. Unsurprisingly, carrying a personal sanitizer bottle was negatively associated with the likelihood of using the sanitizer provided on board. Notably, there was a positive association between incorrect use of masks and avoidance of the sanitizer provided on board. This relationship seemed to highlight the presence of a small, risk-tolerant cluster of passengers who underestimated the role of protective measures in public places.

With regard to attitudes, a perception that the pandemic is a scary event was not a predictor of sanitizer usage. This suggested that hand sanitising was not regarded as a strong preventive measure – certainly not relative to wearing face masks. This is problematic because both measures are important, and the role of hand sanitising cannot be underestimated. Those passengers who thought that

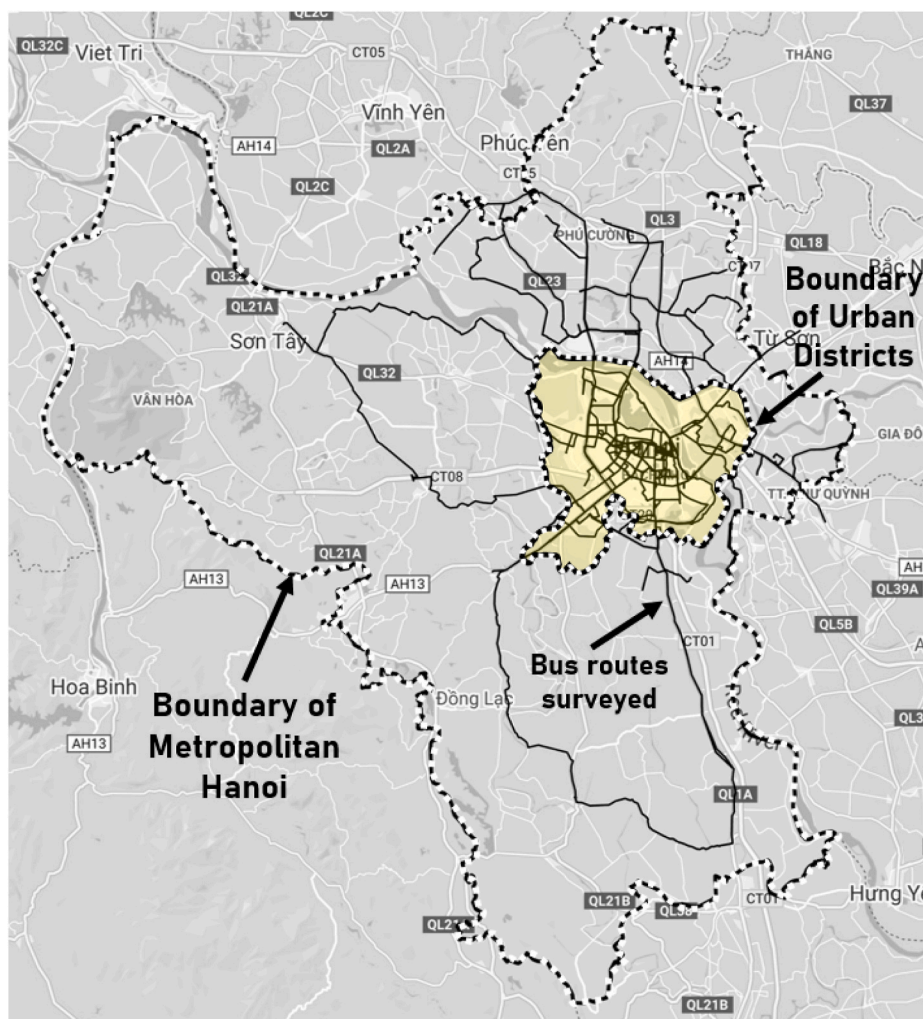


Fig. 3. Surveyed bus routes.

the freely provided sanitizer is of low quality tended to avoid it. And those who were more concerned with comfort and safety (from crime) on buses were too distracted to use the sanitizer.

In Model 2, once again we focused on the frequency of using hand sanitizer. The results, presented in Table 7⁵, were quite similar to those obtained in Model 1. This means that frequent bus travellers behaved like the population at large with regard to protective measures against Covid-19. Of particular concern is the fact that travellers who believed that masks provided sufficient protection were less likely to use hand sanitizer. This misconception needs to be corrected. One small difference between the two models was that the relationship between hand sanitizer use and Factor 3 ('Bus travel can be uncomfortable') was weaker. It might be that frequent passengers were more familiar with buses and, therefore, had developed strategies to ensure their safety and comfort during travel.

5. Conclusion and policy implications

While the Covid-19 pandemic has undermined bus transport worldwide, Hanoi has been able to sustain ridership levels (notwithstanding temporary dips in April–March and August 2020). Notably, the Vietnamese capital has mostly relied on the use of face masks and hand sanitizer during travel, instead of requiring physical distancing on buses. This study revealed that 100% of passengers wore face masks (which were mandated), albeit 11% did so incorrectly, while only 28% of passengers used the hand

⁵ A note on multicollinearity. This can produce unstable p-values, thus confounding influential factors. Therefore, after the logit models were estimated, the variance inflation factors (VIFs) of independent variables were computed to diagnose multicollinearity. For all independent variables, the VIFs were smaller than 4, meaning no risk of multicollinearity (O'Brien, 2007). For the ordered logit model, the Brant test showed that the parallel regression assumption was not violated.

Table 2
Descriptive statistics.

Variables	Values	Sample 1: All respondents (N=570)		Sample 2: Frequent passengers only (N=345)	
		Freq.	%	Freq.	%
Gender	Male	280	49	167	48
	Female	290	51	178	52
Age	<30	426	75	282	82
	30–45	58	10	32	9
	>45	86	15	31	9
Occupation	Students/pupils	368	65	241	70
	Employed or self-employed	104	18	59	17
	Other	98	17	45	13
Education	University degree or higher	185	32	79	23
	No university degree	385	68	266	77
Residential location	Urban area	398	70	248	72
	Non-urban area	145	25	85	25
	Outside Hanoi	27	5	12	3
Bus use frequency	Regular (≥ 4 days/week)	202	35	202	59
	Frequent (2–3 days/week)	143	25	143	41
	Sometimes (2–4 times/month)	117	21	–	–
	Rarely (2–4 times/year) or first time	108	19	–	–
Ticket type	Single ticket	220	39	56	16
	Monthly subscription	314	55	267	77
	Concession	36	6	22	6
Carries heavy luggage [†]	Yes	61	11	–	–
	No	509	89	–	–
Carries personal hand sanitizer bottle	Yes	218	38	149	43
	No	352	62	196	57
Uses mask correctly	Yes	505	89	–	–
	No	65	11	–	–
Has health issues	Yes	92	16	63	18
	No	478	84	282	82
Number of hand sanitizer bottles on board	1	87	15	–	–
	2	445	78	–	–
	≥ 3	38	7	–	–
Uses hand sanitizer on board	Yes	157	28	–	–
	No	413	72	–	–
Frequency of using hand sanitizer on board	Always or nearly always	–	–	69	20
	Some of the time	–	–	157	46
	Never or almost never	–	–	119	34

Notes:

[†]Child prams are not included as it is nearly impossible to carry those on Hanoi buses (bus doors are too narrow and buses have steps on board).

sanitizer provided by bus operators (which was recommended but not required). In addition, some passengers (38%) carried their own bottles of hand sanitizer while travelling. The results suggested that, had more and better hand sanitizer been provided on buses, more people would have used it. (We recommend providing one full bottle per bus door; we also recommend that bottles display labels with the effectiveness rate of the product.)

In combination, Hanoi's measures - full use of face masks and partial use of hand sanitizer - were sufficient to contain three (relatively minor) Covid-19 waves while maintaining regular bus operations most of the time. If all other cities were able to reach these levels of compliance, most would be in much better position vis-à-vis public transport use during the pandemic. Our findings suggest that mandates work much better than awareness-raising campaigns (even in collectivist cultures like Vietnam's), although the latter have a role to play.

Even where certain safety measures are mandated, conductors (ticket collectors) need to be more vigilant and direct passengers to use masks correctly and apply hand sanitizer. They also need to assist the older adults, people with disabilities, pregnant women, and those carrying heavy luggage. Moreover, conductors (and operators in general) need to work on addressing longstanding issues such as pickpocketing, sexual harassment, or abuse of reserved seats on buses, so that passengers are not too preoccupied with those to forget sanitising their hands and fixing their masks.

This is one of the first studies to examine compliance with non-pharmaceutical Covid-19 safety measures (the wearing of masks and

Table 3
Attitudinal variables.

Attitudinal items	Sample 1: All respondents (N=570)		Sample 2: Frequent passengers only (N=345)	
	Mean	SD*	Mean	SD*
The hand sanitizer provided on buses is of low quality	2.932	0.794	2.872	0.804
Sanitizer bottles on buses are usually nearly empty	2.853	0.802	2.846	0.819
There are too few bottles on buses	3.214	0.881	3.209	0.884
Covid-19 is a dangerous disease	4.554	0.730	4.557	0.772
Contracting Covid-19 is serious	4.500	0.731	4.501	0.767
The risk of community infection (in restaurants, markets, buildings) is high	4.293	0.766	4.267	0.831
It is important for me to find a seat or a comfortable standing position when travelling by bus	3.739	0.937	3.771	0.963
I am concerned about pickpocketing when boarding buses	4.339	0.861	4.400	0.881
Using a mask is sufficient protection on buses, I do not need hand sanitizer too	2.609	1.077	2.577	1.060

Notes:

*SD: standard deviation.

Table 4
Solutions to improve 'health and safety' on buses, suggested by passengers.

Proposed solutions	Frequency	%
More hand sanitizer bottles should be provided on buses	182	75%
Quality of hand sanitizer should be improved	98	40%
Passengers should be reminded more often about using sanitizer	65	27%
Conductors should help passengers when using sanitizer	46	20%
Sanitising hands aboard should be mandatory like using masks	31	13%

Table 5
Factors extracted through exploratory factor analysis.

Attitudinal statements (5-point Likert scale)	Factors extracted			
	The pandemic is scary	The sanitizer on-board is no good	Bus travel can be uncomfortable	Masks are sufficiently protective
The hand sanitizer provided on buses is of low quality		0.6762		
Sanitizer bottles on buses are usually nearly empty		0.8179		
There are too few bottles on buses		0.7899		
Covid-19 is a dangerous disease	0.8962			
Contracting Covid-19 is serious	0.9061			
The risk of community infection (in restaurants, markets, buildings) is high	0.8149			
It is important for me to find a seat or a comfortable standing position when boarding buses			0.6292	
I am concerned about pickpocketing when boarding buses			0.8461	
Using a mask is sufficient protection on buses, I do not need hand sanitizer too				0.9378

Notes:

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy: 0.686.

Bartlett test of sphericity: chi-square = 1189.345; degrees of freedom: 36; p-value: 0.000; H_0 : variables are not intercorrelated.

Extraction method: Principal component analysis with eigenvalue > 1.

Rotation method: Oblimin with Kaiser normalization.

Score estimation method: regression.

Variation explained by four factors extracted: 0.7082.

the use of hand sanitizer) on a public transport system in a Global South setting. A major strength of the study is its use of primary data in the form of a large and representative sample of bus passengers. By employing face-to-face interview material, rather than relying on observations, the study revealed a wealth of psychological nuances that support or undermine compliance. As for shortcomings, the findings cover the short-term effects of the pandemic on bus travel. Also, the Covid-19 prevalence has been quite low in Hanoi relative to other major cities around the world. The question remains of how public transport will be impacted in the long term if the pandemic continues for an extended period. As the world is experiencing a climate emergency in addition to a public health crisis, this question is crucial. To answer it, studies similar to ours, possibly controlling for more variables, will need to be conducted periodically in different settings around the world.

Table 6
Results of Model 1 (binary logistic regression).

Variables			
<i>Dependent variable</i>			
Does passenger use hand sanitizer on board?			
1 = uses hand sanitizer			
0 = does not use hand sanitizer			
<i>Independent variables</i>	<i>Coefficient</i>	<i>SE</i>	<i>P> z </i>
Gender (ref = Male)			
Female	−0.499**	0.217	0.022
Age (ref = Under 30)			
30–45	−0.351	0.463	0.448
>45	−1.010*	0.516	0.051
Occupation (ref = Student/pupil)			
Employed or self-employed	.0773	0.367	0.833
Other	−0.300	0.457	0.512
Education (ref = University degree or higher)			
No university degree	0.227	0.224	0.313
Living area (ref = urban area)			
Non-urban area	0.482**	0.245	0.049
Outside Hanoi	−0.417	0.556	0.453
Bus use frequency (ref = Regular, i.e. ≥ 4 days/week)			
Frequent (2–3 days/week)	−0.442	0.289	0.126
Sometimes (2–4 times/month)	0.128	0.331	0.700
Rarely (2–4 times/year) or first time	0.147	0.388	0.705
Ticket type (ref = Single ticket)			
Monthly subscription	−0.174	0.288	0.546
Concession	0.341	0.571	0.550
Carries heavy luggage on board (ref = Yes)			
No	0.113	0.384	0.769
Carries personal hand sanitizer bottle (ref = No)			
Yes	−0.457**	0.222	0.040
Uses mask correctly (ref = No)			
Yes	1.496**	0.482	0.002
Health issues (ref = Yes)			
No	−0.721**	0.286	0.012
Number of sanitizer bottles (ref = 3)			
1	−1.351**	0.471	0.004
2	−1.913**	0.419	0.000
Factor 1: The pandemic is scary	−0.124	0.103	0.230
Factor 2: The sanitizer on-board is no good	−0.517**	0.114	0.000
Factor 3: Bus travel can be uncomfortable	−0.237**	0.105	0.024
Factor 4: Masks are sufficiently protective	−0.116	0.111	0.293
<i>Constant</i>	0.329	0.749	0.660
Number of observations (N)	570		
Log likelihood	−281.0876		
LR chi ² (23)	108.82		
Prob > chi ²	0.0000		
Pseudo R ²	0.1622		

Notes:

*Statistically significant at the 0.1 level.

**Statistically significant at the 0.05 level.

Author statement

The authors would like to thank (1) the Editor-in-Chief and the anonymous reviewers for feedback, (2) the students at Faculty of Transport-Economics, University of Transport and Communications for assistance in data collection, and (3) Mr. Thanh Tung Ha for providing data on the Hanoi buses.

Declaration of competing interest

None.

Table 7
Results of Model 2 (ordered logistic regression).

Variables			
<i>Dependent variable</i>			
Frequency of hand sanitizer use on board			
1 = Never or almost never			
2 = Some of the time			
3 = Always or nearly always			
<i>Independent variables</i>	<i>Coefficient</i>	<i>SE</i>	<i>P> z </i>
Gender (ref = Male)			
Female	−0.332	0.214	0.120
Age (ref = Under 30)			
30–45	0.550	0.453	0.226
>45	0.827	0.521	0.112
Occupation (ref = Student/pupil)			
Employed or self-employed	0.004	0.369	0.992
Other	0.079	0.421	0.851
Education (ref = University degree or higher)			
No university degree	−0.036	0.220	0.871
Residential location (ref = Urban areas)			
Non-urban areas [†]	0.516**	0.238	0.030
Ticket type (ref = Single ticket)			
Monthly subscription	−0.233	0.304	0.443
Concession	−0.989	0.618	0.109
Carries personal sanitizer (ref = No)			
Yes	−0.879**	0.221	0.000
Has health issues (ref = Yes)			
No	−0.425	0.285	0.136
Factor 1: The pandemic is scary	−0.013	0.099	0.895
Factor 2: The sanitizer on-board is no good	−0.227**	0.108	0.035
Factor 3: Bus travel can be uncomfortable	−0.178*	0.105	0.090
Factor 4: Masks are sufficiently protective	−0.227**	0.112	0.043
/cut1	−1.727	0.452	
/cut2	0.540	0.442	
Number of observations	345		
Log likelihood	−336.75474		
LR chi ² (15)	49.14		
Prob > chi ²	0.0000		
Pseudo R ²	0.0680		

Notes:

*Statistically significant at the 0.1 level.

**Statistically significant at the 0.05 level.

[†]Because very few respondents lived in other cities, they were grouped with those living in Hanoi's metropolitan region.

Brant test results: chi²: −10.63; df: 15; p > chi²: 0.779. A significant test statistic provides evidence that the parallel regression assumption has been violated.

References

- Ahorsu, D.K., Lin, C.-Y., Imani, V., Saffari, M., Griffiths, M.D., Pakpour, A.H., 2020. The fear of COVID-19 scale: development and initial validation. *Int. J. Ment. Health Addiction*. <https://doi.org/10.1007/s11469-020-00270-8>.
- Alam, S.J., Werth, B., 2008. Studying emergence of clusters in a bus passengers seating preference model. *Transport. Res. C Emerg. Technol.* 16, 593–614. <https://doi.org/10.1016/j.trc.2007.11.005>.
- Buckey, P., 2020. Modal share changes due to COVID-19: the case of Budapest. *Transport. Res. Interdiscip. Perspect.* 8, 100141. <https://doi.org/10.1016/j.trip.2020.100141>.
- CDC, 2020. Coronavirus disease 2019 (COVID-19) [WWW Document]. Centers for disease control and prevention. <https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/older-adults.html> (accessed 11.22.20).
- CNN, 2020. How Vietnam Managed to Keep its Coronavirus Death Toll at Zero [WWW Document]. <https://edition.cnn.com/2020/05/29/asia/coronavirus-vietnam-intl-hnk/index.html>.
- de Haas, M., Faber, R., Hamersma, M., 2020. How COVID-19 and the Dutch 'intelligent lockdown' change activities, work and travel behaviour: evidence from longitudinal data in The Netherlands. *Transport. Res. Interdiscip. Perspect.* 6, 100150. <https://doi.org/10.1016/j.trip.2020.100150>.
- De Vos, J., 2020. The effect of COVID-19 and subsequent social distancing on travel behavior. *Transport. Res. Interdiscip. Perspect.* 5, 100121. <https://doi.org/10.1016/j.trip.2020.100121>.
- Ding, N., Zhai, Y., 2021. Crime prevention of bus pickpocketing in Beijing, China: does air quality affect crime? *Secur. J.* 34, 262–277. <https://doi.org/10.1057/s41284-019-00226-1>.
- van Doremalen, N., Bushmaker, T., Morris, D.H., Holbrook, M.G., Gamble, A., Williamson, B.N., Tamin, A., Harcourt, J.L., Thornburg, N.J., Gerber, S.I., Lloyd-Smith, J.O., de Wit, E., Munster, V.J., 2020. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N. Engl. J. Med.* <https://doi.org/10.1056/NEJMc2004973>.

- Dzisi, E.K.J., Dei, O.A., 2020. Adherence to social distancing and wearing of masks within public transportation during the COVID 19 pandemic. *Transport. Res. Interdiscip. Perspect.* 7, 100191. <https://doi.org/10.1016/j.trip.2020.100191>.
- Funk, S., Salathé, M., Jansen, V.A.A., 2010. Modelling the influence of human behaviour on the spread of infectious diseases: a review. *J. R. Soc. Interface* 7, 1247–1256. <https://doi.org/10.1098/rsif.2010.0142>.
- Guellich, A., Tella, E., Ariane, M., Grodner, C., Nguyen-Chi, H.-N., Mahé, E., 2021. The face mask-touching behavior during the COVID-19 pandemic: observational study of public transportation users in the greater Paris region: the French-mask-touch study. *J. Transp. Health* 21, 101078. <https://doi.org/10.1016/j.jth.2021.101078>.
- Hirose, R., Ikegaya, H., Naito, Y., Watanabe, N., Yoshida, T., Bandou, R., Daidoji, T., Itoh, Y., Nakaya, T., 2020. Survival of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and influenza virus on human skin: Importance of hand hygiene in Coronavirus Disease 2019 (COVID-19). *Clin. Infect. Dis.* <https://doi.org/10.1093/cid/ciaa1517>.
- Hoang-Tung, N., Kato, H., The Huy, T., Le Binh, P., Duy, L., 2020. Impacts of the introduction of bus rapid transit on travel behaviors of commuters in Hanoi, Vietnam: a quasi-experimental approach. *Case Stud. Transp. Pol.* <https://doi.org/10.1016/j.cstp.2020.10.002>.
- Homburg, A., Stolberg, A., 2006. Explaining pro-environmental behavior with a cognitive theory of stress. *J. Environ. Psychol.* 26, 1–14. <https://doi.org/10.1016/j.jenvp.2006.03.003>.
- Jenelius, E., Cebecauer, M., 2020. Impacts of COVID-19 on public transport ridership in Sweden: analysis of ticket validations, sales and passenger counts. *Transport. Res. Interdiscip. Perspect.* 8, 100242. <https://doi.org/10.1016/j.trip.2020.100242>.
- Lazarus, R.S., 1994. *Emotion and Adaptation*, first ed. Oxford Univ. Press, New York.
- Li, J., Nguyen, T.H.H., Coca-Stefaniak, J.A., 2020. Coronavirus impacts on post-pandemic planned travel behaviours. *Ann. Tourism Res.* <https://doi.org/10.1016/j.annals.2020.102964>, 102964.
- Machida, M., Nakamura, I., Saito, R., Nakaya, T., Hanibuchi, T., Takamiya, T., Odagiri, Y., Fukushima, N., Kikuchi, H., Amagasa, S., Kojima, T., Watanabe, H., Inoue, S., 2020. Incorrect use of face masks during the current COVID-19 pandemic among the general public in Japan. *Int. J. Environ. Res. Publ. Health* 17, 6484. <https://doi.org/10.3390/ijerph17186484>.
- Mahmood, A., Egan, M., Pervez, S., Alghamdi, H.A., Tabinda, A.B., Yasar, A., Brindhadevi, K., Pugazhendhi, A., 2020. COVID-19 and frequent use of hand sanitizers; human health and environmental hazards by exposure pathways. *Sci. Total Environ.* 742, 140561. <https://doi.org/10.1016/j.scitotenv.2020.140561>.
- Ministry of Health, 2020. Chính thức bỏ quy định giãn cách hành khách trên máy bay, xe bus... từ 7/5 [Official Removal of the Social Distancing Regulation on Public Transport Vehicles Since May 7] [WWW Document]. Bộ Y tế - Trang tin về dịch bệnh viêm đường hô hấp cấp COVID-19. <https://moh.gov.vn/-/chinh-thuc-bo-quy-inh-gian-cach-hanh-khach-tren-may-bay-xe-bus-tu-7-5> (accessed 11.16.20).
- Musselwhite, C., Avineri, E., Susilo, Y., 2020. Editorial JTH 16 –The Coronavirus Disease COVID-19 and implications for transport and health. *J. Transp. Health* 16, 100853. <https://doi.org/10.1016/j.jth.2020.100853>.
- Nguyen, H.N., Tu, S.S., Nguyen, M.H., 2020a. Evaluating the maiden BRT corridors in Vietnam. *Transp. Commun. Sci. J.* 71, 4. <https://doi.org/10.25073/tcsj.71.4.3>.
- Nguyen, N.P.T., Hoang, T.D., Tran, V.T., Vu, C.T., Fodjo, J.N.S., Colebunders, R., Dunne, M.P., Vo, T.V., 2020b. Preventive behavior of Vietnamese people in response to the COVID-19 pandemic. *PLoS One* 15, e0238830. <https://doi.org/10.1371/journal.pone.0238830>.
- Nguyen, M.H., 2021. Factors influencing home-based telework in Hanoi (Vietnam) during and after the COVID-19 era. *Transportation*. <https://doi.org/10.1007/s11116-021-10169-5>.
- Nguyen, M.H., Armoogum, J., 2021. Perception and preference for home-based telework in the COVID-19 era: a gender-based analysis in Hanoi, Vietnam. *Sustainability* 13, 3179. <https://doi.org/10.3390/su13063179>.
- Nguyen, M.H., Armoogum, J., 2020. Hierarchical process of travel mode imputation from GPS data in a motorcycle-dependent area. *Trav. Behav. Soc.* 21, 109–120. <https://doi.org/10.1016/j.tbs.2020.06.006>.
- Nguyen, M.H., Armoogum, J., Nguyen Thi, B., 2021a. Factors affecting the growth of e-shopping over the COVID-19 era in Hanoi. *Vietnam. Sustainability* 13, 9205. <https://doi.org/10.3390/su13169205>.
- Nguyen, M.H., Pojani, D., Nguyen, T.C., Ha, T.T., 2021b. The impact of Covid-19 on children's active travel to school in Vietnam. *J. Transport Geogr.*, 103191 <https://doi.org/10.1016/j.jtrangeo.2021.103191>.
- Nguyen, M.H., Ha, T.T., Le, T.L., Nguyen, T.C., 2017. Challenges to development of bus system evidence from a comparative analysis of surveys in Hanoi. In: *Transportation for a Better Life: Mobility and Road Safety Managements*. Presented at the Atrans Annual Conference, Bangkok, Thailand, pp. 1–10.
- Nguyen, M.H., Ha, T.T., Tu, S.S., Nguyen, T.C., 2019a. Impediments to the bus rapid transit implementation in developing countries – a typical evidence from Hanoi. *Int. J. Unity Sci.* 4, 464–483. <https://doi.org/10.1080/12265934.2019.1577747>.
- Nguyen, M.H., Pojani, D., 2018. Why do some BRT systems in the Global South fail to perform or expand? In: Shifan, Y., Kamargianni, M. (Eds.), *Preparing for the New Era of Transport Policies: Learning from Experience, Advances in Transport Policy and Planning*. ELSEVIER ACADEMIC PRESS, pp. 35–61. <https://doi.org/10.1016/bs.atpp.2018.07.005>.
- Nguyen, Y.-L.T., Nghiem, T.-D., Le, A.-T., Bui, N.-D., 2019b. Development of the typical driving cycle for buses in Hanoi, Vietnam. *J. Air Waste Manag. Assoc.* 69, 423–437. <https://doi.org/10.1080/109662247.2018.1543736>.
- Nguyen-Phuoc, D.Q., Nguyen, H.A., De Gruyter, C., Su, D.N., Nguyen, V.H., 2019. Exploring the prevalence and factors associated with self-reported traffic crashes among app-based motorcycle taxis in Vietnam. *Transport Pol.* 81, 68–74. <https://doi.org/10.1016/j.tranpol.2019.06.006>.
- Nguyen-Phuoc, D.Q., Young, W., Currie, G., De Gruyter, C., 2020. Traffic congestion relief associated with public transport: state-of-the-art. *Publ. Transp.* 12, 455–481. <https://doi.org/10.1007/s12469-020-00231-3>.
- Nivette, A., Ribeaud, D., Murray, A., Steinhoff, A., Bechtiger, L., Hepp, U., Shanahan, L., Eisner, M., 2021. Non-compliance with COVID-19-related public health measures among young adults in Switzerland: insights from a longitudinal cohort study. *Soc. Sci. Med.* 268, 113370. <https://doi.org/10.1016/j.socscimed.2020.113370>.
- O'brien, R.M., 2007. A caution regarding rules of thumb for variance inflation factors. *Qual. Quant.* 41, 673–690. <https://doi.org/10.1007/s11135-006-9018-6>.
- OECD, 2018. *OECD Urban Policy Reviews: Viet Nam*, OECD Urban Policy Reviews. OECD Publishing. <https://doi.org/10.1787/9789264286191-en>.
- Orro, A., Novales, M., Monteagudo, Á., Pérez-López, J.-B., Bugarín, M.R., 2020. Impact on city bus transit services of the COVID-19 lockdown and return to the new normal: the case of A Coruña (Spain). *Sustainability* 12, 7206. <https://doi.org/10.3390/su12177206>.
- Pojani, D., Stead, D., 2015. Sustainable urban transport in the developing world: beyond megacities. *Sustainability* 7, 7784–7805. <https://doi.org/10.3390/su7067784>.
- Prather, K.A., Wang, C.C., Schooley, R.T., 2020. Reducing transmission of SARS-CoV-2. *Science* 368, 1422–1424. <https://doi.org/10.1126/science.abc6197>.
- Rocklöv, J., Sjödin, H., Wilder-Smith, A., 2020. COVID-19 outbreak on the Diamond Princess cruise ship: estimating the epidemic potential and effectiveness of public health countermeasures. *J. Trav. Med.* 27 <https://doi.org/10.1093/jtm/taaa030>.
- Selam, M.N., 2020. Hand sanitizers marketed in the streets of Addis Ababa, Ethiopia, in the era of COVID-19: a quality concern. *Risk Manag. Healthc. Pol.* 13, 2483–2487. <https://doi.org/10.2147/RMHP.S284007>.
- Shen, Y., Li, C., Dong, H., Wang, Z., Martinez, L., Sun, Z., Handel, A., Chen, Z., Chen, E., Ebell, M.H., Wang, F., Yi, B., Wang, H., Wang, X., Wang, A., Chen, B., Qi, Y., Liang, L., Li, Y., Ling, F., Chen, J., Xu, G., 2020. Community outbreak investigation of SARS-CoV-2 transmission among bus riders in eastern China. *JAMA Intern. Med.* 180, 1665–1671. <https://doi.org/10.1001/jamainternmed.2020.5225>.
- Sipe, N.G., 2020. Cars rule as coronavirus shakes up travel trends in our cities [WWW Document]. In: *The Conversation*. <http://theconversation.com/cars-rule-as-coronavirus-shakes-up-travel-trends-in-our-cities-142175> (accessed 8.28.20).
- Sung, J., Monschauer, Y., 2020. Changes in Transport Behaviour During the Covid-19 Crisis – Analysis. IEA [WWW Document]. <https://www.iea.org/articles/changes-in-transport-behaviour-during-the-covid-19-crisis> (accessed 9.19.20).
- Teixeira, J.F., Lopes, M., 2020. The link between bike sharing and subway use during the COVID-19 pandemic: the case-study of New York's Citi Bike. *Transport. Res. Interdiscip. Perspect.* 6, 100166. <https://doi.org/10.1016/j.trip.2020.100166>.

- Tirachini, A., Cats, O., 2020. COVID-19 and public transportation: current assessment, prospects, and research needs. *J. Pub. Transp.* 22 <https://doi.org/10.5038/2375-0901.22.1.1>.
- TRAMOC, 2019. *The Annual Report of Bus Services in Hanoi*. Hanoi.
- Tuan, V.A., Mateo-Babiano, I.B., 2013. Motorcycle taxi service in Vietnam – its socioeconomic impacts and policy considerations. *J. Eastern Asia So. Transp. Stud.* 10, 13–28. <https://doi.org/10.11175/easts.10.13>.
- Wang, C., Liu, L., Hao, X., Guo, H., Wang, Q., Huang, J., He, N., Yu, H., Lin, X., Pan, A., Wei, S., Wu, T., 2020. Evolving epidemiology and impact of non-pharmaceutical interventions on the outbreak of coronavirus disease 2019 in Wuhan, China. *medRxiv*. <https://doi.org/10.1101/2020.03.03.20030593>, 2020.03.03.20030593.
- World Bank, 2020. *Best Practice in City Public Transport Authorities' Responses to COVID-19 : A Note for Municipalities in Bulgaria*. Policy Notes, Washington, DC.
- Yeung, Y., 2007. Vietnam: two decades of urban development. *Eurasian Geogr. Econ.* 48, 269–288. <https://doi.org/10.2747/1538-7216.48.3.269>.
- Zhao, S., Zhuang, Z., Ran, J., Lin, J., Yang, G., Yang, L., He, D., 2020. The association between domestic train transportation and novel coronavirus (2019-nCoV) outbreak in China from 2019 to 2020: a data-driven correlational report. *Trav. Med. Infect. Dis.* 33, 101568. <https://doi.org/10.1016/j.tmaid.2020.101568>.
- Zheng, R., Xu, Y., Wang, W., Ning, G., Bi, Y., 2020. Spatial transmission of COVID-19 via public and private transportation in China. *Trav. Med. Infect. Dis.* 34, 101626. <https://doi.org/10.1016/j.tmaid.2020.101626>.